

2003 SURF Summer Seminars and Tours

May 27 First official work day and Orientation for Session I students

May 30 “How’s It Going” Rap Session

This was a general session for students to discuss their expectations and those of their advisors and to air any concerns or feedback about things to date.

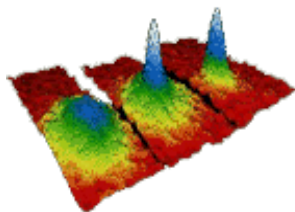
June 4 NIST Virtual Library (NVL) Demos and NIST Research Library Tour

The sessions provided an overview and tour that includes demonstrations of the Library facilities, both manual and computer-based.

June 6 Steven L. Rolston
NIST Physics Laboratory, Atomic Physics Division

Condensates, Qubits, and Quantum Mechanics

We live in a classical world, but we know that the microscopic world is described by the weird world of quantum mechanics, which allows for the



possibility of an object being in two different places at the same time, for example. Some of the consequences of quantum mechanics include the existence of Bose-Einstein condensates (BECs), where many atoms coalesce into a single, identical, indistinguishable state, and the

possibility of a quantum computer, a device that may out-compute any computer constructed with classical physics. Dr. Rolston discussed the work in the NIST Laser Cooling and Trapping Group to use BECs to form the building blocks of a quantum computer, confronting some of the oddities of quantum mechanics along the way.

June 10 Charles A. Wilkie
Marquette University, Department of Chemistry

Fire Performance of Clay-Polymer and Graphite-Polymer Nanocomposites

Over the past three years, our efforts have been directed in four areas: the preparation and characterization of polymer-graphite nanocomposites, on studies that relate to mechanism of FR in nanocomposites, on the

development of new thermally-stable clays and on the development of a high-throughput method to evaluate synergy with conventional FR materials. In his presentation, Prof. Wilkie addressed all of these topics.

June 11 NIST Safety Orientation for Summer Students

The session provided an overview, including how to report emergencies, use of personal protective equipment, general safety, office ergonomics, lab safety, and radiation safety.

June 12 Emil Simiu
NIST Building and Fire Research Laboratory, Materials and Construction Research Division

Chaotic Transitions in Deterministic and Stochastic Dynamical Systems: Applications of the Melnikov Method in Engineering, Physics, and Neuroscience

We describe the classical Melnikov method, a tool which provides information on the behavior of deterministic planar systems that may exhibit chaotic transitions, i.e., apparently random escapes from and captures into “safe” regions of phase space (e.g., the regions in which a boat subjected to wave excitation will not capsize). We then introduced a unified treatment of deterministic and stochastic systems that extends the applicability of the classical Melnikov method to physically realizable stochastic planar systems with additive, state-dependent, colored, or dichotomous noise. The extended method yields the novel result that motions with transitions are chaotic for either deterministic or stochastic excitation. It explains the role in the occurrence of transitions of the system and excitation characteristics, and is a powerful modeling and identification tool. We illustrate the application of the Melnikov method in mechanical engineering, naval architecture, oceanography, physics, nonlinear control, stochastic resonance, and neurophysiology.

June 13 Richard Kuhn
NIST Information Technology Laboratory, Computer Security Division

Quantum Cryptography – Today and Tomorrow OR How to Make and Break Quantum Cryptosystems (Without Being an Expert in Quantum Mechanics)

This talk provided a quick introduction to cryptography, explained why quantum cryptosystems are important, and how they work. After

reviewing the basic quantum mechanisms for key generation, it was shown their use in practical cryptographic protocols, and what quantum cryptosystems exist today. Showing how to break some recently proposed quantum protocols illustrated the difficulties of doing crypto protocols right, but also provided a better understanding of their properties. The talk concluded with the discussion of possible real-world uses for quantum cryptographic products.

June 16 First official work day and Orientation for Session 2 students

June 24 Human Robot Interaction
Manufacturing Engineering Laboratory, Intelligent Systems Division

During their stay at NIST, SURFers had a chance to participate in a 45-minute experiment on human robot interaction. Each participant was asked to fill out a questionnaire and interact with a robot. The experiment was to determine what information users need to effectively and efficiently interact with robots and the design evaluation methodologies to determine if the necessary information is presented appropriately.

June 24 Evangelos Manias
Pennsylvania State University, Department of
Materials Science and Engineering

***Approaches for the Design and Quantitative
Characterization of Challenging Polymer/Clay
Nanocomposites***

Melt processable polymer/clay nanocomposites have been realized for a very wide range of polymers. Two classes of polymers still provide challenges in achieving high performance hybrids composites: apolar polymers, such as polypropylene, and high-temperature polymers, such as syndiotactic-polystyrene. The approaches we developed to address the distinctly different challenges in these two cases of polymers will be presented, including approaches involving functionalization of the polymers and ones involving non-traditional modifications for the clay fillers. Examples of materials properties and examples of TEM methodologies to quantify the dispersion of the fillers will also be presented.



June 24 Frank Gayle
NIST Materials Science and Engineering Laboratory, Metallurgy Division

Analysis of Structural Steel in the NIST World Trade Center Investigation

Last year the National Institute of Standards and Technology became the lead agency in an investigation of the World Trade Center (WTC) disaster.



The investigation addresses many aspects of the catastrophe, from occupant egress to factors affecting how long the Twin Towers stood after being hit by the airplanes, with the goal of gaining valuable information for the future. A major part of the investigation is the metallurgical analysis of structural steel from the Twin Towers. The analysis includes characterization of mechanical properties, failure modes, and temperature excursions seen by the steel. This talk on the metallurgical investigation will describe the structure of the towers, steel recovered from Ground Zero, and special issues faced in the analysis of the steel.

June 25 SURF Picnic – NIST Picnic Grove

The SURF Directors provided the burgers, salads, snacks, and sodas. The SURF students were responsible for the entertainment, Frisbees, music, etc.



June 25 David Newell
NIST Electronics and Electrical Engineering Laboratory, Electricity Division

The Electronic Kilogram

In the International System of Units (SI), the kilogram is the last base unit to be defined in terms of an artifact, a century-old platinum-iridium alloy cylinder. This talk will describe one effort towards a new definition of the kilogram in terms of invariant quantities, the NIST (National Institute of Standards and Technology) Electronic Kilogram project. The project uses a watt balance which measures the ratio of mechanical to electrical work, linking the meter, the artifact kilogram, and the second to the practical realizations of the ohm and the volt derived from the quantum Hall and the Josephson effects. In 1998, the NIST watt balance set an upper limit on the drift rate of the artifact kilogram of 2×10^{-8} /yr (PRL Sept. 21, '98). By using the theoretical values for the Josephson and von Klitzing constants, the same results yield an SI determination of Planck's

constant with a combined relative uncertainty of 8.7×10^{-8} , the most accurate determination to date.

June 27 Terrell Vanderah
NIST Materials Science and Engineering Laboratory, Ceramics Division

Talking Ceramics

In the last three decades communications technologies have been completely transformed by the “wireless revolution.” Devices such as cell phones are now so common that many consumers are forgoing the hard-wired versions altogether. Yet, this remarkable technological explosion could not have taken place without several key historical events, such as Marconi’s first wireless transmission across the Atlantic Ocean in 1901, and the discovery of the transistor almost 50 years later. Also critical was the discovery of a small number of enigmatic ceramic materials with unique properties permitting them to be used as “dielectric resonators” and filters; i.e., “talking ceramics,” which were the subject of Dr. Vanderah’s talk.

June 30 NIST Safety Orientation for Summer Students – 2nd SURF Group Entrance

The session provided an overview, including how to report emergencies, use of personal protective equipment, general safety, office ergonomics, lab safety, and radiation safety.

July 2 Daniel Krieger
Goddard Space Flight Center,
Equal Opportunity Office

NASA Research Center Tour



Through a former SURF student now at NASA, 25 SURF students were able to visit the NASA Research Center and attend a talk on the NASA Mars Program. Due to the popularity of the tour, a lottery was necessary to pick the 25 “winners” who were able to attend the tour.

July 3

Ted Vorburger

NIST Manufacturing Engineering Laboratory, Precision Engineering Division

Bullet Metrology for Crime Scene Investigation

Bullets and casings, when fired or ejected from guns, pick up characteristic surface markings that are unique to the weapon. By analyzing these signatures, firearms examiners can connect a particular firearm to criminal acts. Automated optical inspection systems linked to large databases greatly aid these ballistics investigations by performing the tedious job of down-selecting the likely candidate matches for the examiners to inspect manually. We have developed standard bullets and prototype standard casings to help verify that these optical systems are operating properly. We will first describe case studies showing the successful use of the optical inspection systems to solve violent crimes in several U.S. cities and then describe the standard bullets and casings, how they are manufactured, and their intended use.

July 8

Frederick W. Mowrer

University of Maryland, Department of Fire Protection

Geometric Effects on the Fire Resistance of Structural Steel Elements

Standard methods have been developed and are used in current design practice to determine by calculation the fire resistance rating of structural steel elements protected with spray-applied fire resistive materials (SFRMs). These calculation methods are based on simplified analysis of heat transfer through the SFRM material to the steel substrate. This analysis assumes one-dimensional heat transfer in Cartesian coordinates. Based on this analysis, the ratio of the volume per unit length to the surface area per unit length, expressed in terms of the "W/D ratio," is the governing parameter for the steel element. For cylindrical elements, such as the steel rods in the floor joists of the World Trade Center twin towers, this analysis is inappropriate because of the increasing surface area of the insulated element with increasing insulation thickness. Numerical heat transfer analyses have been performed in both Cartesian and cylindrical coordinates that demonstrate the reduced fire resistance associated with a given thickness of insulation on a cylindrical rod relative to a flat element with the same W/D ratio. As the thickness of insulation is increased, the relative fire resistance rating of the cylindrical element diminishes further with respect to the planar element. The assumption and bases for these

numerical heat transfer analyses are described along with the results of these calculations, which demonstrate the importance of these geometric effects on the fire resistance of structural steel elements.

July 11

Dan Madrzykowski
Building and Fire Research Laboratory, Fire Research Division

Fight Fire with Research

Each year approximately 4,000 people die and 23,000 people are injured due to fires. In addition, on average 100 firefighters die and more than 80,000 firefighters are injured in the line of duty. The Fire Research Division at NIST is using a wide range of methods, from computational fluid dynamics to instrumenting buildings and burning them down, to develop a better understanding of fire and how to protect people from it. This presentation focused on the research being conducted to improve firefighter safety. NIST, in cooperation with the U.S. Fire Administration, is investigating new test methods for firefighter protective clothing, thermal imaging cameras and Personal Alert Safety Systems (PASS). NIST is also working with the National Institute of Occupational Safety and Health (NIOSH) to understand the fire behavior when firefighter line-of-duty deaths occur. NIST-developed computer models, FDS and Smokeview, can provide insight into “real” fires with results that can show how the fire behavior may have led to the fatalities.



July 16

Jordan Goodman and Michael Coplan
University of Maryland

University of Maryland Graduate Program

Dr. Goodman, chairman of the UMD Physics Department, and Dr. Coplan, director of the UMD Chemical Physics Program, spoke about their department/program and the research done at the University of Maryland. This was followed by a discussion of graduate school in general, and applying to graduate programs in particular.

July 18

Michael Vecchione
Smithsonian Institution, National Museum of Natural History

Weird Deep-Sea Squids and the Nature of Natural History

The recent report in the journal ***Science*** (294, 2505 (2001)) of unusual squids that have been encountered in very deep waters around the world has generated considerable interest by the press and the public. These sightings highlight how little is known about life in the largest ecosystem, by far, on earth. These findings provide a good example of the importance of basic observations in advancing scientific knowledge.

July 21

NASA REU Program Visit to NIST

On July 2, about 25 SURFers toured the NASA facilities and invited their counterparts at NASA to check out NIST. Thirty-five students from the NASA REU program toured the nanomagnetism, calibration support for NASA's Earth Observing System, integrating sphere-based UV chamber, and the 3D testing device labs.

July 22

Bradley A. Williams
Naval Research Laboratory, Navy Technology Center for Safety and Survivability, Combustion Dynamics Section

In-situ Optical Diagnostics in Real-Scale Fire Tests: Capabilities and Implementation

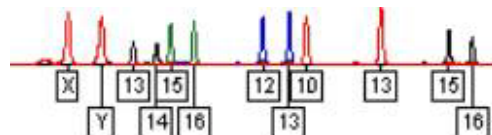
Large scale fire tests present challenging problems of achieving measurement of a number of factors, including temperature, concentrations of fuel, oxygen, gaseous suppressants, suppression by-products (e.g., hydrogen fluoride for fluorocarbon suppressants), and number densities and sizes of particles or droplets of condensed phase suppressants. In their fire test facility in Chesapeake Beach, MD, they have tested a number of suppression concepts and configurations in enclosed chambers ranging from 1000 ft³ to 10,500 ft³, simulating shipboard flammable liquid storerooms. In these tests we have used three in situ diagnostic instruments, hardened to withstand the fire environment. Fourier Transform Infrared Spectroscopy is used to determine concentrations of fluorocarbon suppressant, hydrogen fluoride and carbonyl fluoride by-products, as well as carbon monoxide and dioxide, and fuel and water vapor. For determining oxygen concentrations we have developed a laser diode based sensor, able to measure an absolute O₂ concentration directly, free from corrections for water vapor or liquid

water. Finally a commercial laser-based instrument for direct imaging of particles and droplets gives critical information about condensed phase suppressants. Our approach to optical diagnostics differs from that taken by most other laboratories in that we have employed these diagnostics in-situ, rather than as part of an extractive system. Advantages and trade-offs between these two approaches will be discussed.

July 25

Peter Vallone
Chemical Science and Technology
Laboratory, Biotechnology Division

***Forensic DNA Typing: Application
to Mass Disaster Investigations,
Paternity Testing and Human
Identification***



Over the last 10 years DNA testing has become increasingly popular for human identification purposes. DNA typing is commonly used for paternity testing, identification of mass disaster victims and forensic human identification. The primary role of DNA typing experiments is to differentiate between individuals based on their genetic blueprint.

Typically, 10 to 15 autosomal genetic markers known to exhibit variation in the human genome are probed. With current forensic testing methods the probability of a random match between two unrelated individuals is up to 1 in 3 trillion. The use of polymerase chain reaction (PCR) coupled with high throughput instrumentation has enabled researchers to type sub-nanogram (a blood spot the size of a pinhead) quantities of DNA in approximately 5 hours. DNA tests are continually evolving. Currently in development are assays that exhibit greater sensitivity as well as gender and species specificity. At NIST we are providing standards for forensic laboratories, developing new DNA typing technologies, and evaluating novel genetic markers to assist the forensic community.

July 29

Marc F. Desrosiers
Physics Laboratory, Ionizing Radiation Division

Anthrax in the Mail: NIST Calibration Services to the Rescue

Scientists in the NIST ionizing radiation program played a critical role in the government's response to the past anthrax attacks. Under the direction of the Office of Science and Technology Policy, NIST led the multi-agency technical task force (U.S. Postal Service, Department of Defense, Department of Energy, Food and Drug Administration, and the U.S.

Department of Agriculture) and facilitated the adaptation of current irradiation technology to decontaminate the U.S. mail. High-energy x-ray and electron beams are proving to be effective in eradicating anthrax in contaminated mail. The talk detailed the fundamentals of this technology, as well as chronicled NIST's efforts to alleviate this problem. NIST's role in new Homeland Security projects was also presented.

July 30

David Blackburn
Electronics and Electrical Engineering Laboratory, Semiconductor
Electronics Division

The Future of Semiconductor Micro/Nano Electronics

Since their invention in the middle of the 20th century, the transistor and the integrated circuit have led almost continuous revolutions in communications and computing. This has all been made possible by remarkable advancements in the science and engineering of the transistor and the IC itself. Today, there are serious concerns that fundamental physical limits and manufacturing cost will bring these advancements to a halt. The talk looked at the science and engineering of the Metal-Oxide-Semiconductor Field-Effect-Transistor (MOSFET), the heart and brain of today's ICs, and how it's continual shrinking has made the communications and computing resolutions possible. Potential roadblocks to continued shrinking were discussed, and the talk concluded with the micro/nano electronics industry's visions of the future 'transistor' and EEEL's response.

August 1

Mr. Donald Swenholt
Donald Swenholt Associates, Inc.



Giving Successful Presentations

Mr. Swenholt presented a few techniques and up-to-date procedures to assist the students in presenting their talks for the end-of-the-program SURF student symposium.

August 5

University of Maryland, College Park Tour

A number of SURFers toured the Physics, Chemistry, Electronics & Electrical Engineering, and Computer Science departments at the University to check out the possibilities.

August 6 Pentagon Tour

The SURFers had the great opportunity of touring The Pentagon. The tour route was approximately 1 1/2 miles in length and lasted for about 90 minutes. The tour covered about 20 items of interest that included the mission of the Department of Defense and each of its branches of services, and numerous displays that highlighted and depicted significant moments in military history.

August 7 Drs. Fahim Sadek and Michael A. Riley
Building and Fire Research Laboratory, Materials and Construction
Research Division

Database-Assisted Design for Wind Effects on Structures

The presentation introduced the concept and applications of database-assisted design (DAD) for wind loading on low- and high-rise buildings. Historically, standard provisions for wind loads on buildings have been based on summary tables or plots suitable for slide rule calculations. The accuracy inherent in these methods is far lower than that of current methods used for stress computation. DAD allows engineers to use a database of existing wind tunnel pressure data, along with user-friendly software tools, to accurately predict the wind loads on a building. The presentation detailed the use of DAD, and demonstrated software developed at NIST for the purpose of demonstrating the capabilities of this new design approach. The results of on-going research shows that significant improvements in the main wind-load resisting system and component design can be achieved by using DAD and associated structural reliability tools, thus accounting realistically for the complexity of the wind loading as well as for the stochasticity and knowledge uncertainties affecting wind effects calculations. In the presentation DAD's capability to obtain, for the first time in a wind engineering context, realistic estimates of ultimate limit states due to local or global buckling failure were illustrated. It was shown that DAD is ideally suited for use with data likely to be obtained in the future by Computational Fluid Dynamics methods. The need for assuring quality control procedures for wind tunnel testing so that inter-laboratory comparisons of test results and wind tunnel certifications can be conducted effectively were discussed.

August 11 Final Presentations by SURF Students moderated by invited guests

August 11 Lunch with special invited guests

August 12 Final Presentations by SURF students moderated by invited guests

August 13 Final Presentations by SURF students moderated by invited guests

August 14 Final Presentations by SURF students moderated by invited guests

August 15 Last Day for SURF Students



The SURF Directors treated all 113 SURF (66 schools) students to a farewell party of pizza and soda. The party gave the students and Directors a chance to exchange plans (maybe to apply again next year), talk about their summer at NIST, and what their hopes are for their upcoming school year.